China Economic Review 30 (2014) 618–631

Contents lists available at ScienceDirect

China Economic Review

College admissions in China: A mechanism design perspective ☆

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ARTICLE INFO

Article history:
Received 1 May 2013
Received in revised form 7 May 2013
Accepted 27 August 2013
Available online 3 September 2013

JEL classification:
C70
C92
D63
D78

Keywords:
College admissions in China
Mechanism design
Experiment

ABSTRACT

This paper justifies the evolution of the college admissions system in China from a mechanism design perspective. The sequential choice algorithm and the parallel choice algorithm used in the context of China's college admissions system are formulated as the well-studied Boston mechanism and the Simple Serial Dictatorship mechanism. We review both theoretical and experimental mechanism design literature in similar assignment problems. Studies show that the Boston mechanism does not eliminate justified envy, is not strategy-proof and is not Pareto-efficient. The Simple Serial Dictatorship mechanism eliminates justified envy, is strategy-proof and is Pareto-efficient, thus outperforming the Boston mechanism in all three criteria. This result provides justification for the transition in recent years from the sequential choice algorithm to the parallel choice algorithm in China's college admissions practices.

1. Introduction

College admission (also called “Gaokao”) has been a widely debated topic in China. Each year, millions of high school graduates compete for college seats in the summer. The competition is described as “a stampede of a thousand soldiers and ten horses across a single log bridge”. Being admitted by a college has profound implications for a student's outcome in the labor market in the future and even determines the course of a student's life.

College admissions in China are centralized processes via standardized tests. Each province has a student placement office that assigns high school graduates to colleges slots. This office organizes a National College Entrance Examination for students planning to attend the colleges and ranks the students according to test scores. Students are also asked to report a list indicating preferences over colleges. Given the ranking of students via test scores and students' reported preferences over colleges, the student placement office assigns students to college slots under a specific algorithm. The sequential choice algorithm used for years has been criticized by the public for unfairness as students with high test scores may have worse assignments and poor incentive as students manipulate their true preferences. To fix these problems, variants of the parallel choice algorithm have been implemented in many provinces, starting with Hunan province in 2003. The key innovation for the parallel choice algorithm is that students can put several “parallel” colleges for each choice in decreasing desirability, which presumably reduces risk with first choices. Field data show that this type of algorithm has achieved great success, alleviating unfairness and incentive problems.

While the reform of the assignment algorithm in China's college admissions was developed through a trial and error process, we propose a mechanism design approach to provide justification for this evolution. Mechanism design is the art of designing institutions

☆ I would like to thank Stéphane Robin and anonymous referees for helpful comments.
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http://dx.doi.org/10.1016/j.chieco.2013.08.006

that align individual incentives with overall social goals (Chen & Ledyard, 2008). Within the past decades, economists have benefited from mechanism design theory and its field applications, gaining understanding of how existing institutions have evolved. The mechanism design approach has also been used to provide advice on a handful of real-life assignment problems, such as the design of the FCC spectrum auction (McMillan, 1994; Milgrom, 2000), the redesign of an entry-level labor market for new doctors (Roth & Peranson, 1999), and the redesign of public school allocations (Abdulkadirouglu, Pathak, & Roth, 2005; Abdulkadirouglu, Pathak, Roth, & Sonmez, 2005), etc. Such rich research on similar assignment problems can provide excellent insights on the evolution of China's college admissions system, as well as on how to improve the current admissions processes.

In this paper, we formalize the college admissions in China as a mechanism design problem and review the studies of mechanism design theories and experiments with similar assignment problems to make a systematic comparison of the two algorithms (mechanisms) used in China's college admissions. The comparison follows three criteria: elimination of justified envy, strategy-proofness, and Pareto efficiency. Elimination of justified envy is a basic fairness axiom, which in this case means that a student with a better test score should be assigned to a more preferred college. Strategy-proofness is the central notion of incentive compatibility, which means that revealing true preference is a weakly dominant strategy for each student. Pareto efficiency is on the welfare issue, which means that no other assignment should be possible that would make every student weakly better off and at least one student strictly better off. The studies on similar assignment problems justify field findings and debate regarding China's college admissions practices: the Boston mechanism does not eliminate justified envy, is not strategy-proof and not Pareto-efficient; the Simple Serial Dictatorship mechanism has desirable properties for the elimination of justified envy, strategy-proofness, and Pareto-efficiency.

The review is organized as follows. In Section 2, we review college admissions in China and its historical evolution through the assignment algorithms. In Section 3, we formalize the college admissions system in China as a mechanism design problem and formally describe the assignment mechanisms (algorithms). In Section 4, we review what the mechanism design theories and experiments have shown about the performances of the two mechanisms to provide justification for the evolution of the admissions processes. Section 5 presents the conclusion and some suggestions on how to improve the current system from a mechanism design perspective.

2. College admissions in China

2.1. College admissions in China as centralized processes

College admissions in China are centralized processes via standardized tests. In each province, there is a student placement office that assigns resident students to colleges. Students planning to attend college are asked to take the National College Entrance Examination, which lasts for two or three consecutive days every summer. This examination usually consists of four component tests: a mathematics test, a Chinese test, a foreign language test, and a comprehensive science test (physics, chemistry and biology) in science category or a comprehensive art test (history, geography and politics) in art category. Then, the student placement office in a given province ranks students in two categories separately according to their aggregate scores on the four component tests.[1]

Each student is also asked to submit a lexicographic list to the student placement office, indicating her preference over colleges and, for each college, her preference over faculties (e.g., business at Peking University is preferred to engineering at Peking University, which is preferred to engineering at Tianjin University which is preferred to business at Tianjin University, etc.). Given the students' reported preference lists and the ranking of students via test scores, two independent steps are required to allocate college slots to students: In the first step, the student placement office assigns students to colleges under a certain assignment algorithm; in the second step, faculties are allocated within assigned colleges under a certain assignment algorithm. During the process, colleges are treated as public goods and have no say for admission decisions.[2]

This centralized process was established in 1952 by the National Ministry of Education after years of decentralized examinations and admissions. Prior to 1950, each college organized its own entrance examination and admission system to admit students. Like other decentralized processes, these college admissions systems suffered from a coordination problem: Some qualified students had no time to apply for ordinary colleges after being rejected by the top colleges, and some ordinal colleges could not admit enough students at the same time. To fix this problem, 73 colleges formed three regional alliances in 1950, and each alliance implemented a centralized process for admissions. Subsequently, the Ministry of Education decided to organize the first National College Entrance Examination and to assign students via national centralized processes.

The transition from decentralized processes to centralized ones in China is far from unique. Many markets for the allocation of indivisible and heterogeneous goods face similar failures and have been fixed by the design of appropriate centralized clearing houses (Roth, 2008). A representative example is the entry-level labor market for new doctors in the United States. The market for new doctors long suffered from the problem of the unraveling of appointment dates, in which offers by hospitals were made far in advance of actual employment, and later the problem of congestion, in which hospitals and new doctors had no time to accept and reject offers (Roth, 1984). Such market failures led to a reorganization of the market by means of a centralized clearing house, which then effectively resolved the problem. Why did these centralized procedures achieve success? Niederle, Roth, and Sonmez (2008), in their market design survey, conclude that a centralized clearing house can make markets thick and uncongested, and can prevent an unraveling of the market.

[1] Students are classified into two categories: science and art. Each student either takes a comprehensive science test if in science category or a comprehensive art test if in art category, and is ranked accordingly. For example, a student is ranked highly among students in science category if she takes the science test and has a high aggregate score.

[2] In this paper "have no say" mainly means colleges are not active agents and their welfare is not considered.